

SWANQUARTER NATIONAL WILDLIFE REFUGE

Swanquarter Wilderness

Report on Wilderness Character Monitoring

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U.S. FISH AND WILDLIFE SERVICE

This report is part of a national initiative to establish baseline wilderness character for all the National Wildlife Refuges with designated wilderness. The measures for each wilderness were developed with refuge staff and reviewed at the national level.



Pete Campbell, Project Leader, Mattamuskeet NWR Complex

Date

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Date

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INTRODUCTION

This wilderness character monitoring (WCM) program represents an interagency initiative designed to provide a standardized, yet dynamic, means of assessing current conditions, and monitoring progressive trends in wilderness—both locally at individual wilderness areas, and broadly across the National Wilderness Preservation System. Drawing substance from the words of the Wilderness Act of 1964, this program creates a hierarchical monitoring framework (outlined on pg. 2) charged with feeding five “qualities” of wilderness (described on pg. 3), which serve as a collective representation of wilderness character. Monitoring measures represent nuts and bolts manifestations of specificity and significance for each individual wilderness area, and afford a balance of pertinence between local and regional/national scales. Ultimately, this monitoring program seeks to answer the following fundamental questions:

- How is wilderness character changing over time?
- How do stewardship actions affect trends in wilderness character?

, and in so doing, provides:

- Information for improving on-the-ground wilderness stewardship, policy review, and implementation based on credible data that are consistently collected and endure over time as personnel change;
- accountability for legal and policy mandates “to preserve wilderness character” that apply to all four wilderness management agencies;
- a set of key wilderness stewardship goals that are common across all the agencies with responsibility for wilderness and those that are tied to the legislative direction of the 1964 Wilderness Act; and
- a tool for communicating wilderness stewardship needs and priorities within the agencies and with the public.

Successful implementation of this WCM program will thereby improve the ability of the four wilderness management agencies to fulfill the primary mandate of the Wilderness Act of 1964 (Sec. 4 [b]): “to preserve wilderness character”.

Further explanation of conceptual and technical details of this monitoring program can be found in *Keeping It Wild: An Interagency Strategy to Monitor Trends Across the National Wilderness Preservation System*. The measures selected and discussed in the following report serve the aforementioned purposes in the context of the Swanquarter Wilderness. Baseline assessment of conditions of the Swanquarter Wilderness will be completed by the end of 2014.

An electronic database accompanies this document, and will house all past, present, and future data associated with the selected WCM measures.

Hierarchical Monitoring Framework of Wilderness Character Monitoring

“Wilderness Character”

The combination of biophysical, experiential, and symbolic ideals and relationships that distinguishes wilderness from other lands. The sum of all components below.



Qualities

Primary elements of wilderness character that link directly to the statutory language of the Wilderness Act of 1964. In this framework, all qualities except “other features of value” are necessary to assess trends in wilderness character. Trends in qualities contribute to the computation of the overall trend in wilderness character.



Monitoring Questions

Major elements under each quality that are significantly different from one another. Monitoring questions direct this monitoring so as to answer particular management questions. Trends in monitoring questions contribute to the computation of trends in qualities.



Indicators

Distinct and important elements within each monitoring question. Trends in indicators contribute to the computation of trends in monitoring questions.



Measures

Specific aspects of wilderness, determined by the unique context of each individual wilderness, on which data are collected. Trends in measures contribute to the computation of trends in indicators. At least one measure is required for each indicator.

Qualities of Wilderness Character

Untrammeled

“...an area where the earth and its community of life are untrammeled by man...” and “...generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable” –Wilderness Act of 1964

Wilderness is essentially unhindered and free from [the actions of] modern human control or manipulation

Natural

“...is protected and managed so as to preserve its natural conditions” –Wilderness Act of 1964

Wilderness ecological systems are substantially free from the effects of modern civilization

Undeveloped

“...an area of undeveloped Federal land...without permanent improvement or human habitation...” and “...where man himself is a visitor who does not remain” –Wilderness Act of 1964

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation

Solitude or Primitive and Unconfined Recreation

“...has outstanding opportunities for solitude or a primitive and unconfined type of recreation” –Wilderness Act of 1964

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation

Other Features of Value*

“...may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value”

Wilderness preserves other tangible features that are of scientific, educational, scenic, or historical value

*The “other features of value” quality may not apply to all wilderness areas, and shall likewise only be incorporated into WCM programs where appropriate. Indicators and measures of other features must be identified separately for each wilderness, and not readily fit within one of the other four qualities. Examples include cultural and historical sites, and paleontological features.

HISTORICAL AND ADMINISTRATIVE SETTING OF THE SWANQUARTER WILDERNESS

History of establishing the wilderness

The Swanquarter area underwent consideration for wilderness designation beginning in 1973. Agency, organization, and citizen assessment of the Swanquarter Wilderness proposal culminated in a public hearing, held on April 2, 1974, to comment on the possible incorporation of the area into the National Wilderness Preservation System. According to the public hearing records analysis, the overwhelming majority of statements given supported wilderness designation. The Wilderness Study Summary created by the Bureau of Sport Fisheries and Wildlife indicates that the proposed areas within Swanquarter NWR can best serve refuge objectives if retained in their natural conditions—representing sensitive marsh habitats of a highly primitive and undisturbed condition—, and would therefore benefit from the added protection offered by the Wilderness Act of 1964. On October 19, 1976, the proposed 8,786.92 acres received official wilderness designation, and became known as the Swanquarter Wilderness.

Refuge purposes

Swanquarter NWR was established by presidential order on June 23, 1932, under the authority of the Migratory Bird Conservation Act, which prescribes the following purpose to the refuge:

“...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.”
- *Migratory Bird Conservation Act of 1929 (16 U.S.C. 715d)*

The Fish and Wildlife Act of 1956 prescribed the following purpose to the refuge:

“...for the development, advancement, management, conservation, and protection of fish and wildlife resources...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant or condition of servitude...”
- *Fish and Wildlife Act of 1956 (16 U.S.C. 742f [b] [1])*

In addition, because a portion of the refuge (~54%) is a designated Wilderness Area, the Wilderness Act of 1964 directs the refuge to uphold associated supplemental purposes:

“Wilderness areas...shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness...”
- *Wilderness Act of 1964 (P.L. 88-577)*

Nearly all of Swanquarter NWR lands, and a 27,082-acre portion of the Pamlico Sound adjacent to the refuge, were closed to hunting, taking, or molesting of game birds by Executive Order 2129 on July 18, 1935. The Order was amended in 1977 to allow hunting on specific tracts of the refuge (where it was deemed compatible). Refuge staff continue to enforce the associated restrictions of the Order within the areas where they still apply.

BIOPHYSICAL SETTING OF THE SWANQUARTER WILDERNESS

Geographic setting

Swanquarter National Wildlife Refuge (NWR), located in Hyde County of northeastern North Carolina, consists of 16,411 acres across a combination of non-contiguous mainland and island tracts within the Pamlico Sound. Of this total acreage, 8,787 acres spread across the eastern-most mainland tracts, and the islands occurring within the Pamlico Sound, make up the Swanquarter Wilderness Area.

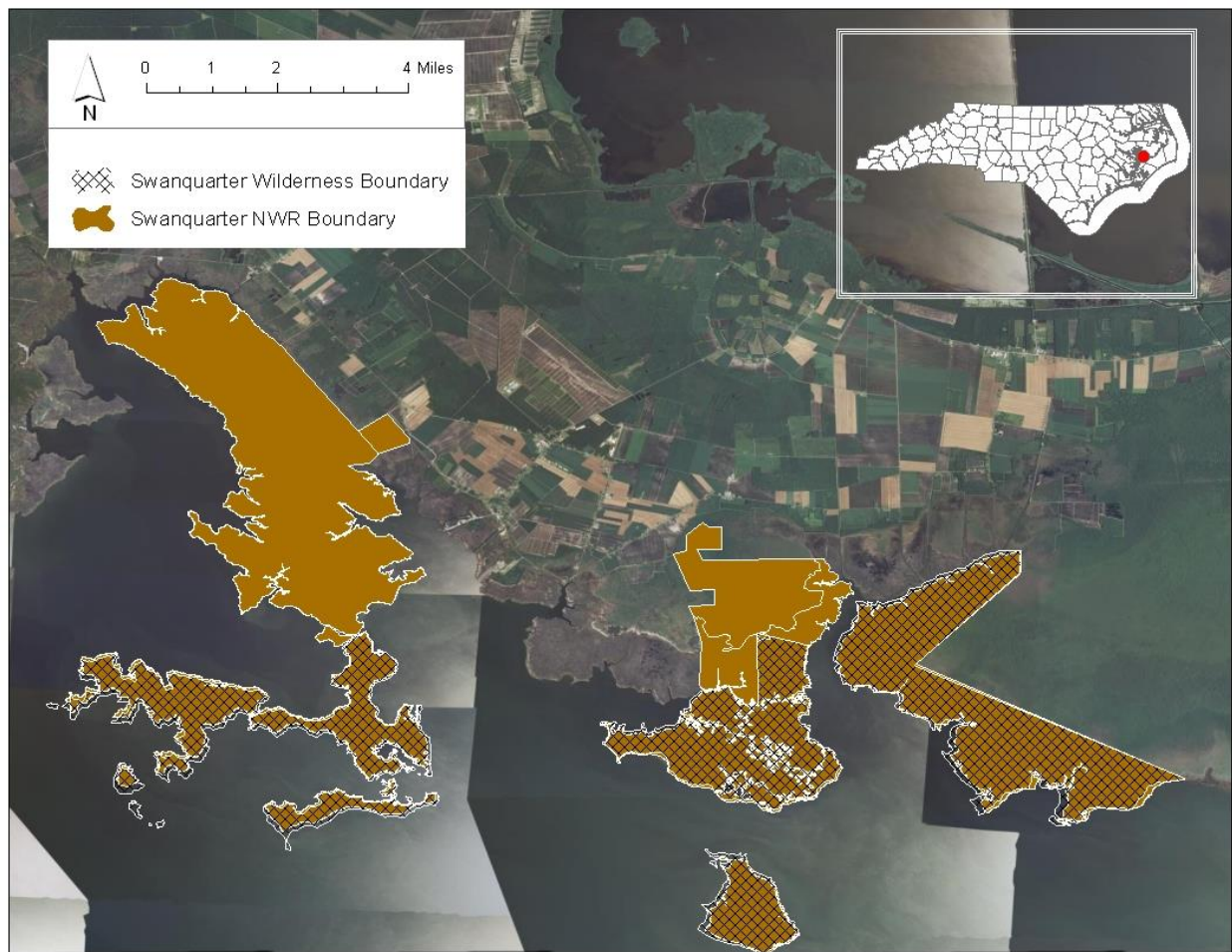


Figure 1: Map of Swanquarter NWR, and the Swanquarter Wilderness contained within.

Ecological setting

The vast majority of the Swanquarter Wilderness, including all island acreage and most mainland acreage, is composed of brackish marsh. Notable exceptions are found on the easternmost mainland tract of the wilderness area, in which estuarine fringe loblolly pine forest, high pocosin, nonriverine swamp forest, and pond pine pocosin habitat types are present.

The wilderness area, as well as the rest of the refuge, serves as an important estuarine resource for wildlife. Together with the surrounding proclamation waters of the Pamlico Sound (established and protected by Executive Order 2129—referenced above), Swanquarter NWR provides winter sanctuary for black ducks, canvasbacks, redheads, and scaup, and nesting habitat for osprey and colonial

waterbirds. The refuge also supports one of the northernmost populations of American alligator, contains potential habitat for the endangered red-cockaded woodpecker, and is located within the red wolf reintroduction area.

Encroachment of marine waters due to sea level rise and erosion represents serious concern for refuge management. Such conditions may contribute to changing ecological community structures within the wilderness area (particularly within the aforementioned eastern-most mainland tract), as a transition to increasingly saline/flooded environments is realized. Furthermore, the potential for complete inundation threatens the very presence of the predominant marsh habitat.

DOCUMENTS CONSULTED

LA 17 Wilderness

- “Mattamuskeet-Swanquarter-Cedar Island-Pea Island Refuges: Wilderness Proposal: Study Summary”
- “Final Environmental Statement: Proposed Mattamuskeet-Swanquarter-Cedar Island-Pea Island Wilderness Area”

LA 10-2 Wilderness Area Management Plan (Swanquarter)

- “Description of the Swanquarter Wilderness Area: Swanquarter National Wildlife Refuge”

LA 4-2 Summary of Rights-of-Way, Legal Mandates, & Acquisition NWR

- “Land Status Summary—Swanquarter NWR”

LA 6-2-1 Swanquarter Acquisition

WR 10-2-2 Colonial Breeding Bird Population and Production

“Swanquarter National Wildlife Refuge: Comprehensive Conservation Plan” (2008)

“Mattamuskeet National Wildlife Refuge Complex: Fire Management Plan” (2013)

Annual Narrative Reports—1976 - 1997

REPORTS: Fire Reports—Swanquarter

History: Swanquarter Refuge

Maps—Swanquarter Acquisition

STAFF CONSULTED

Pete Campbell	<i>Project Leader</i>
Jerry Fringeli	<i>Deputy Manager</i>
John Stanton	<i>Biologist (1994-2002)</i>
Kelly Davis	<i>Biologist (1984-1994)</i>
Kelley Van Druten	<i>Wildland Urban Interface Specialist (Alligator River NWR)</i>
Allison Stewart	<i>SCA Biotech</i>

PROCESS USED FOR IDENTIFYING MEASURES

The process of identifying measures capable of providing both localized insight to refuge staff, and national comment to the greater Fish and Wildlife Service, Division of Inventory & Monitoring, and all parties that may be concerned with the state of the National Wilderness Preservation System, began with an exhaustive review of all relevant archived materials within the refuge's files system. While conducting this initial research, staff were consulted on a casual basis for informal information, suggestions, and impressions based on their time and experience working at the refuge, which helped provide an increased sense of local context, and, in turn, some guidance for honing in on aspects of particular significance.

After completing the thorough review of all available files and resources, the Excel document *Potential Measures for WCM—2013*, part of the electronic resources provided to Wilderness Fellows at training in Fort Collins, was accessed and reviewed. Based on the information obtained from the reviewed files, measures deemed potentially significant to the refuge, and relevant to the assessment of wilderness character from the perspective of the Wilderness Fellow, were selected from the Excel document. A meeting with the refuge Project Leader was then conducted in which he was provided with a copy of the Excel document, and asked to select the measures he felt were appropriate. During this selection process, an open discussion was facilitated to entertain ideas, clarify objectives and terminology, and keep the analysis that went into selecting potential measures in the context of the wilderness area (as opposed to the non-wilderness portion of the refuge). Notes regarding selection and exclusion/elimination of potential measures according to the input of the Project Leader were taken during this meeting, and used as talking points for maintaining productive discussion during the meeting, as well as for reference in future meetings. Ultimately, this meeting served as a common outlet for both parties to discuss their differing interpretations of the various measures, and yielded functional debate and resolutions.

The aforementioned selection process served as an efficient means of paring down the list of potential measures provided within the Excel document, and yielded a prescreened, manageable list of potential measures to be further considered through the prioritization process. The Word document *FWS Wilderness Fellows, Prioritizing Measures Worksheet*, part of the electronic resources provided to Wilderness Fellows at training in Fort Collins, was used at a following meeting with the Project Leader in which the prescribed numerical ranking system was employed to provide further comment on the relevance and feasibility of selected potential measures, and to further refine the list of selected measures. This process ultimately culminated in a semi-finalized list of monitoring measures for wilderness character.

The absolute, finalized measures presented in this report represent the efforts of a perpetual process of reevaluation and refinement. As further meetings were conducted with the Project leader and other consulted parties, and as further conceptual and technical-oriented thought was applied to the list of measures through the drafting of this report, and the specific measure definitions contained within, tweaking on both broad and fine scales occurred. Entire measures were added to and removed from the selected list, and the specific definitions and protocols of these measures were held in a highly malleable state until they found a form capable of adequately representing their associated aspects of wilderness character, and acknowledging the staffing and resource limitations of the refuge. The *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character, Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System*, and the reports of past Wilderness Fellows served as valuable resources throughout this process.

WILDERNESS CHARACTER MONITORING MEASURES

The following section provides comprehensive descriptions of all measures selected for monitoring trends in the wilderness character of the Swanquarter Wilderness. In the interest of clarity, each measure definition includes the following information:

- Baseline year and data value—*baseline information for a given measure*
- Frequency—*how often data values are to be reported for a given measure*
- Significant change—*magnitude by which a given measure's data value must change relative to the previous data value to indicate a change in trend*
- Data adequacy—*reliability of the data for the purpose of accurately assessing trends in a given measure*
- Data source(s)—*personnel and/or places (departments, files, etc.) to be consulted for a given measure's data*
- Data collection protocol—*detailed procedure of how to collect data for a given measure*
- Context and relevance—*any relevant background information, relevance to wilderness character, and guidelines for interpreting trends for a given measure*

Those measures for which data could be collected before the departure of the Wilderness Fellow are displayed, along with their associated baseline year, in the measure definitions below, as well as in the wilderness character monitoring database files. Those measures for which baseline data is still required will be indicated as such:

Baseline Data Value [YEAR]: TBD

throughout the report. Refuge staff will be responsible for collecting this data, and will enter the appropriate values into the database as they are determined. The year corresponding to the first available data value for a given measure will represent the baseline year for said measure, and will likewise be entered into the database. The baseline year for the Swanquarter Wilderness (as a whole) will correspond to the first year in which data for all measures is available, and will be entered into the database under the "Select Wilderness" menu. The initial baseline assessment, and all associated data collection and entry, will be completed by refuge staff no later than the end of the 2014 fiscal year.

Untrammeled Quality

Wilderness is essentially unhindered and free from modern human control or manipulation.

Monitoring Question	Indicator	Measure	Data Source(s)	Frequency (yr.)
What are the trends in actions that control or manipulate the “earth and its community of life” inside wilderness?	Actions authorized by the Federal land manager that manipulate the biophysical environment	1.1 Number of actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water	Project Leader RAPP Report raw data MRAs	1
		1.2 Number of naturally ignited wildfires suppressed	Fire Program S:\Fire\Wildfire Records-- Swanquarter NWR	1
		1.3 Acres of wilderness burned by prescribed fire	Fire Program S:\Fire\Rx Fire Usage-- Swanquarter NWR	1
	Actions <u>not</u> authorized by the Federal manager that manipulate the biophysical environment	1.4 Number of unauthorized actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water; and fire	LE Officer Project Leader LE Database/Incident Reports	1

UNTRAMMELED QUALITY**Actions authorized by the federal land manager that manipulate the biophysical environment**

[Measure 1.1]—Number of actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water

Baseline Data Value [YEAR]: TBD

Frequency: 1 yr.

Significant Change: ANY

Data Adequacy: High

Data Source(s): Project Leader; RAPP Report raw data; MRAs

Data Collection Protocol: The refuge Project Leader will be aware of all actions taken to manipulate natural aspects of the wilderness, including: vegetation, fish, wildlife, insects, disease, soil, and water (supporting data for which can be derived from annual RAPP Report figures, as well as existing MRAs). The total number of such actions taken during a given monitoring period will serve as the data value. Appendix D provides an in-depth guide to the concept of “trammeling”, and what constitutes a trammeling action. Furthermore, Table 1 indicates general rules for counting and reporting the number of actions for this measure.

Table 1: Guidelines for counting and reporting actions to manipulate natural aspects of wilderness

Type of Action	Example	Counting Rule	Reporting
Single action at a single location	Phragmites treated at a single location	Count as one action	Report one action
Single action at multiple locations	Phragmites treated with herbicide at several locations	Count as one action	Report one action for the single species regardless of the number of locations
Multiple actions at a single location	Herbicide is used to treat phragmites and alligator weed at the same location	Count as multiple actions	Report one action for each species (i.e.: one treatment on two species = two actions)
Multiple actions at multiple locations	Mechanical treatment used in addition to herbicides	Count as multiple actions	Report one action for each treatment on each species (i.e.: two treatments on two species = four actions)
Action occurs within a single fiscal year	Phragmites is treated with herbicide between June and July 2007	Count as one action	Report one action
Action spans multiple fiscal years without interruption	Herbicide treatment of phragmites initiated in August 2007 ends in November 2007	Count as one actions	Report as one action in fiscal year 2007

Action spans multiple fiscal years with interruption	Herbicide treatment of phragmites initiated in August 2007 ends in November 2007, and is reinitiated in August 2008	Count as multiple actions	Report as one action in fiscal year 2007 and one action in fiscal year 2008
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Context and Relevance: Historically, there has been a lack of manipulative management actions targeting the Swanquarter Wilderness (a trend that has continued to present day). Notable exceptions to this trend are associated with fire management actions (particularly prescribed burning), which, for the sake of increased clarity, are monitored separately via Measures 1.2 and 1.3. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses authorized actions that manipulate the biophysical environment, and contributes to an evaluation and understanding of the untrammeled quality of wilderness. An increase in the number of actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in such actions indicates an improving trend.

[Measure 1.2]—Number of naturally ignited wildfires suppressed

Baseline Data Value [1985]: 0

Frequency: 1 yr.

Significant Change: ANY

Data Adequacy: High

Data Source(s): Fire Program; S:\Fire\Wildfire Records--Swanquarter NWR

Data Collection Protocol: The refuge Fire Program will be aware of all naturally ignited wildfires within wilderness that received a suppression response. Fire Program personnel will be consulted for this information, which will also be incorporated into the above referenced shared drive file, and the total number of naturally ignited wildfires suppressed within wilderness during a given monitoring period will serve as the data value.

Context and Relevance: According to refuge records, the only suppressed, naturally ignited wildfire occurring within the Swanquarter Wilderness was the Juniper Bay fire of 1996. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses authorized actions that manipulate the biophysical environment, and contributes to an evaluation and understanding of the untrammeled quality of wilderness. An increase in the number of naturally ignited wildfires suppressed within wilderness indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the number of naturally ignited wildfires suppressed indicates an improving trend.

[Measure 1.3]—Acres of wilderness burned by prescribed fire

Baseline Data Value [1991]: 0

Frequency: 1 yr.

Significant Change: ANY

Data Adequacy: High

Data Source(s): Fire Program; S:\Fire\Rx Fire Usage--Swanquarter NWR

Data Collection Protocol: The refuge Fire Program will be aware of all prescribed burns conducted within wilderness, and their associated acreage figures. Fire Program personnel will be consulted for this information, which will also be incorporated into the above referenced shared drive file, and the total number of acres burned by prescribed fire within wilderness during a given monitoring period will serve as the data value for this measure.

Context and Relevance: Prescribed burning has been conducted within the Swanquarter Wilderness in the past, and pending the outcome of a recently initiated Minimum Requirement Analysis (MRA), may well be conducted in the future. This being said, while impacts to the untrammeled quality are acknowledged, the use of prescribed fire is typically authorized for the purpose of improving aspects of the natural quality of wilderness (ex: natural fire regime, vegetation community structure, etc.). This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses authorized actions that manipulate the biophysical environment, and contributes to an evaluation and understanding of the untrammeled quality of wilderness. An increase in the number of acres of wilderness burned by prescribed fire indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the number of acres burned indicates an improving trend.

[Measure 1.4]—Number of unauthorized actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water; and fire

Baseline Data Value [YEAR]: TBD

Frequency: 1 yr.

Significant Change: ANY

Data Adequacy: Moderate—Due to logistical constraints, it will not be possible for the complex's LE officer to patrol the entirety of the wilderness area on a regular basis for unauthorized activity. This being said, the scope of this measure is more concerned with providing refuge management with a relative impression of the frequency of unauthorized trammeling events, rather than an absolute count of all such incidents. The data collected, while perhaps not capable of exhibiting the same degree of accuracy as measures of higher data adequacy, is still viewed as providing the refuge with valuable information.

Data Source(s): LE Officer; Project Leader; LE Database/Incident Reports

Data Collection Protocol: The refuge LE Officer and Project Leader will be aware of all known unauthorized actions taken to manipulate natural aspects of the wilderness, including: vegetation, fish, wildlife, insects, disease, soil, water, and fire. Formal documentation of such incidents will be housed within LE database files. These sources will be consulted, and the total number of such actions taken during a given monitoring period will serve as the data value. Operational definitions of "action" and "unauthorized" are included below for reference. Examples of unauthorized trammeling would include actions by agencies, citizen groups, or individuals that manipulate the biophysical environment, and in many cases would be considered illegal (ex: poaching, arson, etc.). See Appendix D for an in-depth guide to the concept of "trammeling", and what constitutes a trammeling action.

Operational Definitions:

- *Action*— the implementation of an intentional decision to manipulate the biophysical environment.
- *Unauthorized*— any action undertaken by any individual, group, or agency without specific approval by the federal land manager. (Any action that manipulates the biophysical environment of wilderness requires such approval.)

Context and Relevance: Staff and resource limitations, along with the logistical requirements of accessing the Swanquarter Wilderness (~15 miles southwest of complex headquarters [located within Mattamuskeet NWR], and requiring a boat), have historically limited patrol of the wilderness for unauthorized activities. Staff impressions both past (based on annual narratives and other refuge documents) and present indicate that the frequency and extent of such unauthorized actions are believed to be relatively low, but acknowledge that their awareness is limited to their ability to thoroughly patrol the area. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses unauthorized actions to manipulate the biophysical environment, and contributes to an evaluation and understanding of the untrammeled quality of wilderness. An increase in the number of unauthorized actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water; and fire indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in such actions indicates an improving trend.

Natural Quality <i>Wilderness ecological systems are substantially free from the effects of modern civilization.</i>				
Monitoring Question	Indicator	Measure	Data Source(s)	Frequency (yr.)
What are the trends in terrestrial, aquatic, and atmospheric natural resources inside wilderness?	Plant and animal species and communities	2.1 Population dynamics of select native species: Forster's Tern	S:\Refuge Monitoring and Research\Swanquarter Tern Colonies	5
		2.2 Population dynamics of select native species: Common Tern	S:\Refuge Monitoring and Research\Swanquarter Tern Colonies	5
	Physical resources	2.3 Ozone air pollution	FWS NWRS Branch of Air Quality	5
		2.4 Total nitrogen wet deposition	FWS NWRS Branch of Air Quality	5
		2.5 Total sulfur wet deposition	FWS NWRS Branch of Air Quality	5
		2.6 Visibility	FWS NWRS Branch of Air Quality	5
	Biophysical processes	2.7 Acres of wilderness (loss of land area due to erosion)	S:\Wilderness\Erosion	5
		2.8 Cumulative change in marsh sediment height	S:\Refuge Monitoring and Research\Sea level rise I&M RSET Representative	5

[Measure 2.1]—Population dynamics of select native species: Forster’s Tern

Baseline Data Value [YEAR]: TBD

Frequency: 5 yr.

Significant Change: ANY change in the interpreted population dynamics score

Data Adequacy: High

Data Source(s): S:\Refuge Monitoring and Research\Swanquarter Tern Colonies

Data Collection Protocol: Surveys to determine the number of tern colonies and nests within the wilderness will be conducted annually, and the resulting data will be housed within the above referenced shared drive file. Based on 5 year data sets, refuge staff will interpret the population dynamics of Forster’s Tern within the Swanquarter Wilderness, and score the population dynamics of the species according to the following system: 0 = Forster’s Tern population is stable, 1 = Forster’s Tern population is increasing, -1 = Forster’s Tern population is decreasing. The population dynamics score for Forster’s Tern during a given monitoring period will serve as the data value.

Context and Relevance: Forster’s Tern represents one of the characteristic species of the Swanquarter Wilderness, colonizing various marsh islands within the Pamlico Sound. Forster’s Terns are closely linked to the elevated wrack substrate they require for nesting, which may allow this measure to offer additional insight at the habitat level. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on an animal species, and contributes to an evaluation and understanding of the natural quality of wilderness. A population dynamics score of -1 indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a score of 1 indicates an improving trend, and a score of 0 indicates a stable trend.

[Measure 2.2]—Population dynamics of select native species: Common Tern

Baseline Data Value [YEAR]: TBD

Frequency: 5 yr.

Significant Change: ANY

Data Adequacy: High

Data Source(s): S:\Refuge Monitoring and Research\Swanquarter Tern Colonies

Data Collection Protocol: Surveys to determine the number of tern colonies and nests within the wilderness will be conducted annually, and the resulting data will be housed within the above referenced shared drive file. Based on 5 year data sets, refuge staff will interpret the population dynamics of Common Tern within the Swanquarter Wilderness, and score the population dynamics of the species according to the following system: 0 = Common Tern population is stable, 1 = Common Tern population is increasing, -1 = Common Tern population is

decreasing. The population dynamics score for Common Tern during a given monitoring period will serve as the data value.

Context and Relevance: Historically, the Common Tern represented one of the characteristic species of the Swanquarter Wilderness, colonizing various marsh islands within the Pamlico Sound. However, while this species had a dominant presence during the 70's and 80's, a significant decline thereafter is indicated by refuge survey data. Common Terns are closely linked to the sandy substrate they require for nesting, which may allow this measure to offer additional insight at the habitat level. The decline of Common Terns within the Swanquarter Wilderness is currently thought to be associated with storm events and erosion removing this sandy habitat. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on an animal species, and contributes to an evaluation and understanding of the natural quality of wilderness. A population dynamics score of -1 indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a score of 1 indicates an improving trend, and a score of 0 indicates a stable trend.

[Measure 2.3]—Ozone air pollution

Baseline Data Value [2009]: 71.9 ppb

Frequency: 5 yr.

Significant Change: ANY increase or decrease resulting in a change in the “condition” of the data value according to the scoring range below (see comments section)

Data Adequacy: High

Data Source(s): FWS NWRS Branch of Air Quality

Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.

Context and Relevance: Air quality, while largely beyond the control of refuge management, is an important and ever present aspect of wilderness character. Ozone air pollution represents one variable contributing to an assessment of air quality. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on a physical resource, and contributes to an evaluation and understanding of the natural quality of wilderness. An increase in the ozone air pollution metric indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the ozone air pollution metric indicates an improving trend.

Comments: The following scoring range will be used to determine the “condition” of the data value for this measure in the wilderness character monitoring database, and will also serve as a guide for determining significant change:

< 60 ppb - Good
61-75 - Moderate
> 76 - Significant Concern

All data and protocol associated with this measure is the product of the FWS NWRS Branch of Air Quality.

[Measure 2.4]— Total nitrogen wet deposition

Baseline Data Value [2009]: 3.7 kg/ha

Frequency: 5 yr.

Significant Change: ANY increase or decrease resulting in a change in the “condition” of the data value according to the scoring range below (see comments section)

Data Adequacy: Moderate—For wilderness areas where the FWS NWRS Branch of Air Quality does not have air quality monitors in close proximity, data values may have been interpolated

between monitors. Interpolated data have the assigned confidence level of moderate (or, as described in the database, “medium”), and, as per the protocol dictated by the Branch of Air Quality, will not be used to assess a trend.

Data Source(s): FWS NWRS Branch of Air Quality

Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.

Context and Relevance: Air quality, while largely beyond the control of refuge management, is an important and ever present aspect of wilderness character. Total nitrogen wet deposition represents one variable contributing to an assessment of air quality. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on a physical resource, and contributes to an evaluation and understanding of the natural quality of wilderness. As per the protocol dictated by the Branch of Air Quality, being that the current data adequacy of this measure is moderate (the product of interpolation, rather than actual monitored values), a trend will not be assessed for this measure. For the purposes of this wilderness character monitoring program, further assessment will be limited to whether the numerical value calculated for this measure is increasing or decreasing.

Comments: The following scoring range will be used to determine the “condition” of the data value for this measure in the wilderness character monitoring database, and will also serve as a guide for determining significant change:

<1 kg/ha - Good
1-3 - Moderate
> 3 - Significant Concern

All data and protocol associated with this measure is the product of the FWS NWRS Branch of Air Quality.

[Measure 2.5]— Total sulfur wet deposition

Baseline Data Value [2009]: 4.3 kg/ha

Frequency: 5 yr.

Significant Change: ANY increase or decrease resulting in a change in the “condition” of the data value according to the scoring range below (see comments section)

Data Adequacy: Moderate—For wilderness areas where the FWS NWRS Branch of Air Quality does not have air quality monitors in close proximity, data values may have been interpolated between monitors. Interpolated data have the assigned confidence level of moderate (or, as described in the database, “medium”), and, as per the protocol dictated by the Branch of Air Quality, will not be used to assess a trend.

Data Source(s): FWS NWRS Branch of Air Quality

Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.

Context and Relevance: Air quality, while largely beyond the control of refuge management, is an important and ever present aspect of wilderness character. Total sulfur wet deposition represents one variable contributing to an assessment of air quality. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on a physical resource, and contributes to an evaluation and understanding of the natural quality of wilderness. As per the protocol dictated by the Branch of Air Quality, being that the current data adequacy of this measure is moderate (the product of interpolation, rather than actual monitored values), a trend will not be assessed for this measure. For the purposes of this wilderness character monitoring program, further assessment will be limited to whether the numerical value calculated for this measure is increasing or decreasing.

Comments: The following scoring range will be used to determine the “condition” of the data value for this measure in the wilderness character monitoring database, and will also serve as a guide for determining significant change:

<1 kg/ha - Good
1-3 - Moderate
> 3 - Significant Concern

All data and protocol associated with this measure is the product of the FWS NWRS Branch of Air Quality.

[Measure 2.6]— Visibility

Baseline Data Value [2009]: 8.6 dv

Frequency: 5 yr.

Significant Change: ANY increase or decrease resulting in a change in the “condition” of the data value according to the scoring range below (see comments section)

Data Adequacy: High

Data Source(s): FWS NWRS Branch of Air Quality

Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.

Context and Relevance: Air quality, while largely beyond the control of refuge management, is an important and ever present aspect of wilderness character. Visibility represents one variable contributing to an assessment of air quality. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on a physical resource, and contributes to an evaluation and understanding of the natural quality of wilderness. An increase in the visibility metric (expressed as deciview) indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the visibility metric indicates an improving trend.

Comments: The following scoring range will be used to determine the “condition” of the data value for this measure in the wilderness character monitoring database, and will also serve as a guide for determining significant change:

< 2 dv - Good

2-8 - Moderate
> 8 - Significant Concern

All data and protocol associated with this measure is the product of the FWS NWRS Branch of Air Quality.

[Measure 2.7]—Acres of wilderness (loss of land area due to erosion)

Baseline Data Value [1976]: 8,786.92

Frequency: 5 yr.

Significant Change: ANY

Data Adequacy: Moderate—Based on accuracy and precision limitations of digital boundary layers, aerial imagery, and GPS/GIS software.

Data Source(s): S:\Wilderness\Erosion

Data Collection Protocol: Aerial imagery and GIS software will be used to compute the number of terrestrial acres comprising the Swanquarter Wilderness. The number of terrestrial acres of wilderness present during a given monitoring period will serve as the data value.

Context and Relevance: While largely beyond the control of refuge management, land loss due to erosion represents a major concern for the Swanquarter Wilderness. Since its designation in 1976, obvious change has been observed in the geography of the wilderness area, including the total loss of islands. While sea level rise may also be contributing to a loss of terrestrial acreage through inundation (monitored via Measure 2.8), this measure seeks to track loss occurring on a shorter (relative to sea level rise) time scale, which refuge staff and documentation attribute to erosion and contributing storm events. Based on the nature of the observed erosion, as well as dismal climate change projections and their associated implications, this measure may consistently display a degrading trend. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses effects on the biophysical environment, and contributes to an evaluation and understanding of the natural quality of wilderness. A decrease in the number of terrestrial acres of wilderness indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while an increase in the number of terrestrial acres indicates an improving trend.

[Measure 2.8]—Cumulative change in marsh sediment height

Baseline Data Value [2013]: 0

Frequency: 5 yr.

Significant Change: To be determined after more data is available for analysis. A degrading trend may be indicated if it is calculated that marshes are accreting at a slower rate than sea level rise, indicating possible complete inundation, and ultimate loss of marsh habitat.

Data Adequacy: High

Data Source(s): S:\Refuge Monitoring and Research\Sea level rise; Inventory & Monitoring RSET Representative

Data Collection Protocol: There are currently three rod surface elevation table (RSET) stations located within the Swanquarter Wilderness, and each station collects 36 sediment elevation point measurements. To determine the current marsh sediment height (corrected for sea level

rise) for the wilderness, the average of all 36 measurements across all three RSET stations will be taken. The data value sought for this wilderness character measure is the change in marsh sediment height (in millimeters) as compared to the initial sediment elevation measurement obtained during the baseline year of the RSET station (baseline, in this context, refers to the first initial measurements obtained by the RSET station, and does not represent the baseline of the wilderness character measure). To obtain this data value, the initial, averaged, sediment height measurement will be subtracted from the current, averaged, sediment height measurement during a given monitoring period, yielding the cumulative change in sediment height from the initial elevation.

Context and Relevance: Sea level rise, while largely beyond the control of refuge management, represents a major concern for the Swanquarter Wilderness. Brackish marsh accounts for the majority of the habitat provided by the Swanquarter Wilderness, and may be lost due to inundation if marsh accretion cannot keep pace with sea level rise. This measure is relevant to the associated indicator, monitoring question, and quality in that it address effects on the biophysical environment, and contributes to an evaluation and understanding of the natural quality of wilderness. An increase in the cumulative change in sediment height (towards a positive value) indicates an improving trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the cumulative change in sediment height (towards a negative value) indicates a degrading trend. Further clarification concerning details of accurate trend interpretation will become available with the collection of more data (specifically, when a complete 5 yr. data set is available). The Inventory & Monitoring RSET Representative may be consulted at this time for additional guidance as needed.

Undeveloped Quality

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation.

Monitoring Question	Indicator	Measure	Data Source(s)	Frequency (yr.)
What are the trends in non-recreational development and mechanization inside wilderness?	Non-recreational structures, installations, and developments	3.1 Number of authorized physical structures, installations, and developments	Project Leader Real Property Database SAMMS Database	5
	Inholdings	3.2 Acres of Inholdings within wilderness	Project Leader CCP S:\Wilderness	5
	Use of motor vehicles, motorized equipment, and mechanical transport	3.3 Number of projects/events for which use of motorized transport, motorized equipment, or mechanical transport was authorized	Project Leader Fire Program LE Officer MRAs	1

[Measure 3.1]—Number of authorized physical structures, installations, and developments**Baseline Data Value [YEAR]:** TBD**Frequency:** 5 yr.**Significant Change:** ANY**Data Adequacy:** High**Data Source(s):** Project Leader; Real Property Database; SAMMS Database

Data Collection Protocol: The Project Leader will be aware of all authorized physical structures, installations, and developments within wilderness, with supporting data available through the Real Property and SAMMS databases. These sources will be consulted, and the total number of authorized physical structures, installations, and developments within wilderness, during a given monitoring period, will serve as the data value. Temporary installations will be counted the same as permanent structures, and each data value reported will include all temporary installations that occurred within wilderness over the course of the corresponding year (regardless of how long a particular installation may have remained in the wilderness).

Context and Relevance: The only authorized physical structures, installations, or developments currently within wilderness represent relatively minor developments, and include area closure signs (on islands supporting tern colonies), commercial fishing regulation signs posted by the state, and three RSET stations. Fluctuation in the data value is possible based on the addition or removal of area closure signs (primarily dependent upon the number and spatial distribution of tern colonies), but the addition of structures, installations, or developments of a more appreciable nature in the future is not likely. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses the presence of non-recreational structures, installations, and developments within the wilderness, and contributes to an evaluation and understanding of the undeveloped quality of wilderness. An increase in the number of authorized physical structures, installations, and developments within wilderness indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the number of authorized physical structures, installations, and developments within wilderness indicates an improving trend.

[Measure 3.2]—Acres of inholdings within wilderness**Baseline Data Value [1976]:** 0**Frequency:** 5 yr.**Significant Change:** ANY**Data Adequacy:** High**Data Source(s):** Project Leader; CCP; S:\Wilderness

Data Collection Protocol: The refuge Project Leader will be aware of all existing inholdings within the wilderness area, and will be consulted for acreage data. Reference documentation would be found within the refuge CCP and wilderness file. The sum of all inholding acres present during a given monitoring period will serve as the data value.

Context and Relevance: Upon its designation in 1976, the Swanquarter Wilderness inherited no inholdings. Furthermore, no inholdings have been acquired since then, and none are anticipated in the future. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses the presence of inholdings, and contributes to an evaluation and understanding of the undeveloped quality of wilderness. An increase in the number of acres of inholdings indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the number of acres of inholdings indicates an improving trend.

[Measure 3.3]—Number of projects/events for which use of motorized transport, motorized equipment, or mechanical transport was authorized

Baseline Data Value [YEAR]: TBD

Frequency: 1 yr.

Significant Change: ANY

Data Adequacy: High

Data Source(s): Project Leader; Fire Program; LE Officer; MRAs

Data Collection Protocol: The Project Leader will be aware of all projects/events for which use of motorized transport, motorized equipment, or mechanical transport was authorized, as the Project Leader will be responsible for the approval of such requests. Additionally, the refuge Fire Program and LE Officer, representing parties likely to request such authorizations and utilize motorized transport, motorized equipment, or mechanical transport as part of their job duties, may also serve as valuable sources of information. Existing MRAs should also be consulted as sources of official documentation for such projects/authorizations. The Project Leader and other sources as necessary (including, but not limited to, the refuge Fire Program and LE Officer, and any existing MRAs) will be consulted, and the total number of projects/events for which use of motorized transport, motorized equipment, or mechanical transport within wilderness was authorized during a given monitoring period will serve as the data value. General definitions of motorized and mechanical, as pertaining to this measure of wilderness character, have been sourced from the Forest Service's *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*, and are provided below for conceptual reference.

“Motorized Equipment. Machines that use a motor, engine, or other nonliving power sources. This includes, but is not limited to, such machines as chain saws, aircraft, snow mobiles, generators, motorboats, and motor vehicles. It does not include small battery or gas powered hand carried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment.”

“Mechanical Transport. Any contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and that is powered by a living or nonliving power source. This includes, but is not limited to, sailboats, hand gliders, parachutes, bicycles, game carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snow shoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts.”

Context and Relevance: Historically, use of motorized transport, motorized equipment, or mechanical transport has been relatively limited in the Swanquarter Wilderness. However, due to its location within the Pamlico Sound, motorboats are often required for transportation of personnel and supplies. If a motorboat is landed on wilderness shoreline, then it has technically entered the wilderness, and would contribute towards the associated count of this measure. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses the use of motor vehicles, motorized

equipment, and mechanical transport within wilderness, and contributes to an evaluation and understanding of the undeveloped quality of wilderness. An increase in the number of projects/events for which use of motorized transport, motorized equipment, or mechanical transport was authorized indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the number of such projects/events indicates an improving trend.

Solitude or Primitive and Unconfined Recreation Quality

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.

Monitoring Question	Indicator	Measure	Data Source(s)	Frequency (yr.)
What are the trends for outstanding opportunities for solitude within wilderness?	Remoteness from sights and sounds of people inside the wilderness	4.1 Area of wilderness occupied by marine debris	S:\Wilderness\Marine Debris Surveys	1
	Remoteness from occupied and modified areas outside the wilderness	4.2 Intrusions on the natural soundscape	S:\Wilderness\Soundscape Surveys	1
What are the trends in outstanding opportunities for primitive and unconfined recreation inside wilderness?	Facilities that decrease self-reliant recreation	4.3 Agency provided recreation facilities	Project Leader Real Property Database SAMMS Database	5
	Management restrictions on visitor behavior	4.4 Management restrictions on visitor behavior	Project Leader	5

[Measure 4.1]—Area of wilderness occupied by marine debris**Baseline Data Value [YEAR]:** TBD**Frequency:** 1 yr.**Significant Change:** 25%**Data Adequacy:** Moderate—Based on potential for estimate variations between surveyors, and limited surveying opportunities.**Data Source(s):** S:\Wilderness\Marine Debris Surveys**Data Collection Protocol:** Marine debris surveying will be conducted once per year across the Swanquarter Wilderness. The surveyor(s) will travel the perimeter of the wilderness islands and shorelines by boat, and the following procedure will be utilized to quantify the presence of marine debris within the Swanquarter Wilderness:

While surveying the shored perimeter of the wilderness, each observed occurrence of marine debris will be expressed via the product of two parameters: area of shoreline occupied by debris, and percent cover of debris within that particular area. To obtain the first data component, the surveyor(s) will estimate the length of shoreline (in feet) occupied by a distinct occurrence of marine debris, and multiply that number by the estimated width/depth of shoreline (in feet) occupied by the same observed occurrence of debris, thereby yielding the area (ft²) occupied by a given occurrence of marine debris. To obtain the second data component for a given observation of marine debris, the surveyor(s) will estimate the percent cover of debris within the estimated area of shoreline (reference diagrams of percent cover will be used to aid in the accuracy and precision of these estimations—see Appendix E). The estimated values of area and percent cover for a given observed occurrence of marine debris will then be multiplied, and the resulting value constitutes a representation of the quantity of marine debris in the form of area occupied as corrected for percent cover. The corrected area values for all observed occurrences of marine debris throughout the wilderness will be summed, and the total area of wilderness occupied by marine debris (as corrected for percent cover) during a given monitoring period will serve as the data value. An illustration of this complete process based on hypothetical data has been included below for reference (see Figure 2 and Table 2).



Figure 2: Illustration of hypothetical marine debris data collection for a portion of the Swanquarter Wilderness. The blue areas indicate areas of debris, with length and width/depth measurements indicated.

Table 2: Computation of hypothetical marine debris data in accordance with the above described measure protocol.

Occurrence No.	Length of shoreline (ft)	Width/Depth of shoreline (ft)	Area of shoreline (ft ²)	Percent Cover (%)	Area of marine debris (ft ² —corrected)
1	100	10	1000	25	250
2	10	5	50	10	5
3	30	1	30	75	22.5

Context and Relevance: Marine debris has been casually observed on the shorelines of the wilderness area, but attempts to formally survey and quantify its prevalence represents a new initiative for refuge staff. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses remoteness from sights and sounds of people inside the wilderness, and contributes to an evaluation and understanding of the solitude or primitive and unconfined recreation quality of wilderness. An increase in the total corrected area of marine debris indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the total corrected area indicates an improving trend.

[Measure 4.2]—Intrusions on the natural soundscape**Baseline Data Value [YEAR]:** TBD**Frequency:** 1 yr.**Significant Change:** 10**Data Adequacy:** Moderate—Based on limited opportunities for sampling**Data Source(s):** S:\Wilderness\Soundscape Surveys

Data Collection Protocol: Surveys of anthropogenic noise originating from outside the wilderness will be conducted twice per year in conjunction with RSET data collection (soundscape intrusion sampling will begin after collection of all required RSET data). From the first RSET station (SWAN000A), the surveyor(s) will listen for anthropogenic sounds originating from outside the wilderness (ex: motorboats, aircraft, etc.) for a sampling period of 15 minutes, using a stopwatch to measure the collective time of all such sounds experienced during the sampling period. The sum total time (in minutes) anthropogenic noise was experienced between the two annual surveys during a given monitoring period will serve as the data value. The length of the survey periods may be increased as needed should they regularly become maxed out with anthropogenic noise.

Context and Relevance: Due to its location within the Pamlico Sound, motorboats are thought to be the most significant contributors to anthropogenic noise originating from outside the Swanquarter Wilderness. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses remoteness from occupied and modified areas outside of the wilderness, and contributes to an evaluation and understanding of the solitude or primitive and unconfined recreation quality of wilderness. An increase in the total time anthropogenic noise (originating from outside the wilderness) is experienced indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the total time anthropogenic noise is experienced indicates an improving trend.

Comments: Because the RSET protocol specifies structured data collection (i.e.: there are given timeframes during which the data must be collected during the year, and these timeframes remain the same from year to year), performing soundscape intrusion sampling in conjunction with RSET data collection will help to maximize consistency with respect to the time of year and time of day soundscape intrusion data is being collected. This is important, as both time of year and day can have an appreciable influence on the likelihood of experiencing anthropogenic noise.

The measure of intrusions on the natural soundscape for this particular monitoring program emphasizes the importance of the quantity of noise over the quality/intensity of noise, as it was determined that sound intensity may be more susceptible to sporadic variation between sampling periods, and therefore less useful in accurately illustrating long-term trends. Furthermore, as boat traffic is perceived to be the biggest contributor of anthropogenic noise originating from outside the Swanquarter Wilderness, refuge staff feel a change in such traffic and associated anthropogenic noise would be most efficiently tracked via a measure of time.

[Measure 4.3]—Agency provided recreation facilities**Baseline Data Value [1976]:** 0**Frequency:** 5 yr.**Significant Change:** ANY**Data Adequacy:** High**Data Source(s):** Project Leader; Real Property Database; SAMMS Database

Data Collection Protocol: The refuge Project Leader will be aware of all authorized recreational structures and facilities. Additionally, formal documentation of all such structures and facilities would be found within the Real Property database and SAMMS database. These sources will be consulted, and counts of all facilities representing authorized recreational development within wilderness will be collected and totaled. The total count of all such facilities present within wilderness, during a given monitoring period, will serve as the data value. General examples of recreational facilities are provided below for reference. These examples are purely for conceptual reference, and are not intended to be all inclusive, nor representative of the specific recreational facilities likely to occur within this particular wilderness area.

Recreational facilities counted under this measure include, but are not limited to:

- Toilets
- Constructed tent pads or sleeping structures
- Picnic tables
- Developed/permanent fire rings/grates
- Shelters
- Watercraft docking facilities
- Developed water sources

Context and Relevance: The data value produced by this measure serves to quantify the presence and magnitude of recreational facilities within the wilderness. The Swanquarter Wilderness currently has no recreation facilities within it (a characteristic that has remained since its designation in 1976). This characteristic of the Swanquarter Wilderness, while unlikely to change in the near future, is one refuge management and staff would like to see preserved. Monitoring this measure therefore provides a means of communicating the implications of recreational facilities within wilderness to both present and future refuge staff. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses facilities that decrease self-reliant recreation, and contributes to an evaluation and understanding of the solitude or primitive and unconfined recreation quality of wilderness. An increase in the total number of recreation facilities indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the total number of recreation facilities indicates an improving trend.

[Measure 4.4]—Management restrictions on visitor behavior
Baseline Data Value [2013]: 32

Frequency: 5 yr.

Significant Change: ANY

Data Adequacy: High

Data Source(s): Project Leader

Data Collection Protocol: Table 3, sourced from the Forest Service's *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*, contains a list of management restrictions placed on visitor behavior, as well as scores assigned based on the degree of restriction, and the significance of their impact on opportunities for primitive and unconfined recreation. When scoring the restrictions of a given wilderness, a geographical weight is also applied: x1 = restriction applies only to a portion of the wilderness; x2 = restriction applies throughout entire wilderness. Based on the stipulations of management policy within a given monitoring period, the wilderness will be scored, and the total score will serve as the data value. Table 4 illustrates this scoring process for the Swanquarter Wilderness based on management restrictions in place at the time of this report.

Table 3: Index of management restrictions

Category	Score	Type of Restriction
Campfires	0	No regulation
	1	Designated site, above designated elevation, or mandatory setback
	2	Total prohibition
Camping	0	No restriction
	1	Any mandatory setback; designated sites
	2	Assigned sites
	3	Total prohibition
Fees	0	No fees
	1	Fees charged of selected user type
	2	Fees charged of all visitors
Permits	0	No permit or registration
	1	Voluntary self-registration
	2	Mandatory, nonlimiting permit or registration
	3	Mandatory; use limited
Human waste	0	No regulation
	3	Pack out required
Length of stay	0	No restriction on length of stay
	1	Length of stay limited
Stock use	0	No restriction
	1	Mandatory setbacks; no hitching, tethering
	2	Grazing prohibited or feed restricted
	3	No camping with stock; area closures to all stock; or total prohibition

Swimming/bathing	0	No restrictions
	2	Prohibited
Area closure	0	No restriction
	3	Area closed to use
Group size limits	0	No restriction
	1	Group size limits in place
Dogs	0	No restrictions
	1	Required to be on leash
	2	Prohibited

Context and Relevance: Based on the Wilderness Act of 1964, and reinforced through the operational definitions proposed by this monitoring program, outlets for primitive and unconfined recreation represent a major contributing quality to the overall character of wilderness. Management of wilderness includes the creation and enforcement of visitor use/behavior restrictions, which ultimately affect the quality of a visitor's recreational experience. Table 4 indicates the extent of management restrictions associated with the Swanquarter Wilderness at the time of this report (according to the above scoring system). The data value of this measure is not likely to change in the near future, and will therefore likely display a consistent stable trend. This measure is relevant to the associated indicator, monitoring question, and quality in that it addresses management restrictions on visitor behavior, and contributes to an evaluation and understanding of the solitude or primitive and unconfined recreation quality of wilderness. An increase in the management restrictions index score indicates a degrading trend in the context of the measure and associated indicator, monitoring question, and quality, while a decrease in the management restrictions index score indicates an improving trend.

Table 4: Management restrictions score for Swanquarter Wilderness (2013)

Category	Score	Geographic Weight	Total Score
Campfires	2	2	4
Camping	3	2	6
Fees	0	—	0
Permits	0	—	0
Human waste	3	2	6
Length of stay	1	2	2
Stock use	3	2	6
Swimming/bathing	2	2	4
Area closure	3	1	3
Group size limits	0	—	0
Dogs	1	1	1
Total Score			32

MEASURES SUGGESTED FOR FUTURE USE

Natural Quality	
Measure	Reason(s) measure was dropped
Presence of rails within wilderness	A measure of rail presence within the Swanquarter Wilderness was ultimately dropped due to a current lack of established surveying protocol, and time available to develop such a program before the departure of the Wilderness Fellow. This being said, some measure of rail presence is seen as a valuable source of information for refuge management, as the habitat utilized by rails within the wilderness represents a different habitat type compared to the other species monitored through this WCM program (Forster's and Common Terns). It is therefore advised that such a measure be considered for future incorporation into the current WCM program.
Departure from natural fire regime	A measure to track change in the natural fire regime is viewed as beneficial to management, particularly as prescribed burning may be used within the wilderness in the future. Such a measure would be useful to evaluate the appropriateness and effectiveness of such management actions in the context of the natural quality, as well as facilitating a more substantive cost/benefit analysis between realized ecological improvements, and associated trammeling. At the time of this report, however, FRCC data was determined to be inaccurate according to Fire Program staff, and while an alternative means of tracking changes in the natural fire regime is something the Fire Program is looking into developing, it was not ready at the time of this report. This being said, a measure of the change in the natural fire regime is highly recommended for future incorporation into the current WCM program.

DROPPED MEASURES

Untrammelled Quality	
Measure	Reason(s) measure was dropped
Number of research, survey, and monitoring projects that manipulate plants or wildlife	Seen as redundant and less informative when already utilizing a measure of the number of authorized actions to manipulate.
Acreage of wilderness burned due to unauthorized, human ignited fire	Not highly relevant. Unauthorized fire/burning, in the context of wilderness character, requires a level of "intent" akin to arson. Certain highly specific exceptions may apply to the unique contexts of other wilderness areas, but in the case of Swanquarter, unauthorized burning as it relates to this WCM program is restricted to instances of arson. As there is no documented history of arson (acting with intent to manipulate the biophysical environment) within the Swanquarter Wilderness, this measure was deemed irrelevant. The selected measure under this corresponding indicator allows for a broader inclusion of unauthorized actions that manipulate the biophysical environment, which is seen as more useful to staff.
Natural Quality	
Measure	Reason(s) measure was dropped
Number of active osprey nests supported within wilderness	Not relevant. After review of historical data and discussion with previous refuge biologists, it was determined that osprey nesting within the Swanquarter Wilderness is very limited (due to the dominant marsh habitat type), and does not represent a significant aspect of this particular wilderness area.
Number of aquatic pools in wilderness	While aquatic pools may represent important resources within the marsh habitat, tracking appreciable change proved problematic. This measure was ultimately determined to be of lesser significance compared to others under the same indicator, and was therefore dropped.
Landscape fragmentation	While initially thought to be an interesting concept, this measure was determined to have a low level of relevance and vulnerability for this particular wilderness area, as compared to other measures under the same indicator.

CONCLUSION

The above compilation of selected measures provides for an accurate representation of the Swanquarter Wilderness, and contributes to a greater functional understanding of wilderness character and its management. Through careful design and consideration, the finalized list of monitoring measures manages to strike a critical balance between local and national pertinence, thereby exhibiting relevance for both refuge management and staff, and higher regional and national channels.

Due to the small staff and limited resources of the Mattamuskeet-Swanquarter-Cedar Island refuge complex (Swanquarter NWR is currently “unmanned”), efficiency was essential. Logistical limitations drove the development of a distilled list of measures capable of maximizing local relevance, while minimizing demands placed on staff. This focus was applied from the very first measure selection meeting (hence the relatively short list of dropped measures), and persisted through all following processes of measure prioritization and refinement. Ultimately, a measure composition identifying and monitoring the most representative/critical aspects of the Swanquarter Wilderness resulted. This being said, additional (and in some cases, more subtle) details of the Swanquarter Wilderness could be communicated and monitored through the potential addition of other measures, and/or an increase in the frequency of surveying associated with particular measures, pending an increase in available time and resources for the refuge.

For the most part, dramatic changes in wilderness character are not foreseen (at least in the immediate future) for the Swanquarter Wilderness. This being said, impacts associated with sea level rise and erosion, if realized, have the potential to significantly affect wilderness character— particularly in the context of the natural quality. The collection and interpretation of further data contributing to the sea level rise and erosion measures incorporated in this report will hopefully provide additional insight as to the likelihood and magnitude of such effects, and thereby inform and influence the required management and policy response.

As a final note, examination of the above selected measures will indicate a strong similarity with respect to the definition of significant change. The vast majority of measures chosen to assess and represent the intricacies of the Swanquarter Wilderness and its wilderness character specify a significant change value of “ANY”, meaning that any change in the data values of such measures are indicative of a change in the trend of the measures. Explanation for the recurrence of this aspect of the above measure definitions lies within the site-specific context of the Swanquarter Wilderness. Because the Swanquarter Wilderness has historically received little active management and visitor use (likely due in part to the inhospitable nature of the dominant marsh habitat, and the requirement of watercraft for access), and because a large portion of the wilderness area is composed of small island tracts, it stands to reason that changes of any magnitude (even on what might be considered relatively small scales compared to other wilderness areas—particularly larger, more contiguous examples) have the potential to appreciably influence wilderness character. Thus, small scale, a perceived retention of primeval character, and historical managerial restraint have supported the common assignment of “ANY” as a significant change interval for many of the above measures, thereby expressing the perceived sensitivity of this particular wilderness area, and representing increased acknowledgement of local conditions and context.

APPENDIX A – Priority ranking of all measures considered

Directions: In each row, write the potential measure in the left column under the appropriate indicator. Add or delete rows as needed. Use the criteria and ranking guide below to create an overall score for each measure. If the combined score for criteria A and B is ≤ 2 , STOP and do not score criteria C and D. Those measures with the highest overall scores should be the highest priority for assessing trends in wilderness character.

A. Level of significance (the measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness):

High = 3 points, Medium = 2 points, Low = 1 point

B. Level of vulnerability (measures an attribute of wilderness character that currently is at risk, or might likely be at risk over 10-15 years): High = 3 points, Medium = 2 points, Low = 1 point

C. Degree of reliability (the measure can be monitored accurately with a high degree of confidence, and would yield the same result if measured by different people at different times):

High = 3 points, Medium = 2 points, Low = 1 point

D. Degree of feasibility (the measure is related to an existing effort or could be monitored without significant additional effort):

High = 1 point, Low = 0 point (if 0 is given, do not use)

POTENTIAL MEASURE	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	A. Significance	B. Vulnerability	C. Reliability	D. Feasibility	
UNTRAMMELED QUALITY					
Indicator: Authorized actions that manipulate the biophysical environment Measure: Number of actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water	3	1	3	1	8
Indicator: Authorized actions that manipulate the biophysical environment Measure: Number of naturally ignited wildfires suppressed	3	2	3	1	9
Indicator: Authorized actions that manipulate the biophysical environment Measure: Acres of wilderness burned by prescribed fire	3	2	3	1	9
Indicator: Authorized actions that manipulate the biophysical environment Measure: Number of research, survey, and monitoring projects that manipulate plants or wildlife	3	1	3	1	8

Indicator: Unauthorized actions that manipulate the biophysical environment Measure: Number of unauthorized actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water; and fire	3	1	2	1	7
Indicator: Unauthorized actions that manipulate the biophysical environment Measure: Acreage of wilderness burned due to unauthorized, human ignited fire	2	1	3	1	7
NATURAL QUALITY					
Indicator: Plant and animal species and communities Measure: Population dynamics of select native species: Forster's Tern	3	3	3	1	10
Indicator: Plant and animal species and communities Measure: Population dynamics of select native species: Common Tern	3	3	3	1	10
Indicator: Plant and animal species and communities Measure: Number of active osprey nests supported within wilderness	1	1	—	—	X
Indicator: Plant and animal species and communities Measure: Presence of rails within wilderness	3	3	2	1	9
Indicator: Physical resources Measure: Air quality measures (Ozone air pollution, Total nitrogen wet deposition, Total sulfur wet deposition, Visibility)	2	2	2	1	7
Indicator: Physical resources Measure: Number of aquatic pools in wilderness	2	2	3	1	8
Indicator: Biophysical processes Measure: Acres of wilderness (loss of land area due to erosion)	3	3	2	1	9
Indicator: Biophysical processes Measure: Cumulative change in marsh sediment height	3	3	2	1	9
Indicator: Biophysical processes Measure: Departure from natural fire regime	3	2	3	1	9
Indicator: Biophysical processes Measure: Landscape fragmentation	2	1	2	1	6
UNDEVELOPED QUALITY					
Indicator: Non-recreational structures, installations, or developments Measure: Number of authorized physical structures, installations, and developments	3	1	3	1	8

Indicator: Inholdings Measure: Acres of inholdings within wilderness	3	1	3	1	8
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport Measure: Number of projects/events for which non-emergency use of motorized transport, motorized equipment, or mechanical transport was authorized	3	2	3	1	9
SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY					
Indicator: Remoteness from sights and sounds of people inside the wilderness Measure: Area of wilderness occupied by marine debris	3	1	2	1	7
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Intrusions on the natural soundscape	3	2	2	1	8
Indicator: Facilities that decrease self-reliant recreation Measure: Agency provided recreation facilities	3	1	3	1	8
Indicator: Management restrictions on visitor behavior Measure: Management restrictions on visitor behavior	3	1	3	1	8
Other Features of Value Quality (if applicable)					
Indicator: N/A Measure: N/A	—	—	—	—	—

APPENDIX B – Summary of effort required for wilderness character monitoring

Comment: The following table has been adapted from the original materials provided, and differs from that featured in reports of past Wilderness Fellows. This adapted design serves to communicate an estimated indication of time required to collect data for each measure in the absence of more concrete temporal figures (due to the lack of data collection completed for a number of measures before the departure of the Wilderness Fellow).

Quality	Indicator	Measure	Index of estimated time required to gather and interpret data for each measure (1: < 1 hr, 2: 1-3 hrs, 3: >3 hrs)	Comments
Untrammeled	Actions authorized by the Federal land manager that manipulate the biophysical environment	1.1 Number of actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water	1	
		1.2 Number of naturally ignited wildfires suppressed	1	
		1.3 Acres of wilderness burned by prescribed fire	1	

Quality	Indicator	Measure	Index of estimated time required to gather and interpret data for each measure (1: < 1 hr, 2: 1-3 hrs, 3: >3 hrs)	Comments
	Actions <u>not</u> authorized by the Federal land manager that manipulate the biophysical environment	1.4 Number of unauthorized actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water; and fire	1	
Natural	Plant and animal species and communities	2.1 Population dynamics of select native species: Forster's Tern	3	Requires professional interpretation and associated field work
		2.2 Population dynamics of select native species: Common Tern	3	Requires professional interpretation and associated field work
	Physical resources	2.3 – 2.6 Air quality measures	1	All data provided by NWRS Branch of Air Quality

Quality	Indicator	Measure	Index of estimated time required to gather and interpret data for each measure (1: < 1 hr, 2: 1-3 hrs, 3: >3 hrs)	Comments
	Biophysical processes	2.7 Acres of wilderness (loss of land area due to erosion)	2	Requires GIS analysis
		2.8 Cumulative change in marsh sediment height	3	Associated fieldwork
Undeveloped	Non-recreational structures, installations, and developments	3.1 Number of authorized physical structures, installations, and developments	1	
	Inholdings	3.2 Acres of Inholdings within wilderness	1	
	Use of motor vehicles, motorized equipment, and mechanical transport	3.3 Number of projects/events for which non-emergency use of motorized transport, motorized equipment, or mechanical transport	1	

Quality	Indicator	Measure	Index of estimated time required to gather and interpret data for each measure (1: < 1 hr, 2: 1-3 hrs, 3: >3 hrs)	Comments
		was authorized		
Solitude or Primitive and Unconfined Recreation	Remoteness from sights and sounds of people inside the wilderness	4.1 Area of wilderness occupied by marine debris	3	Associated fieldwork
	Remoteness from occupied and modified areas outside the wilderness	4.2 Intrusions on the natural soundscape	2	Associated fieldwork
	Facilities that decrease self-reliant recreation	4.3 Agency provided recreation facilities	1	
	Management restrictions on visitor behavior	4.4 Management restrictions on visitor behavior	1	

Title of staff involved in identifying, prioritizing, and selecting measures	Staff time to identify, prioritize, and select measures (hours)	Comments
Project Leader	20	consulted in formal meetings for identification, prioritization, and ultimate selection and definition of measures
Deputy Refuge Manager	3	consulted regarding context and relevance of potential measures, and associated data sources
Biologist (YEARS)	3	consulted regarding context and relevance of potential measures, and associated data sources
Biologist (1984-1994)	3	consulted regarding context and relevance of potential measures, and associated data sources
Wildland Urban Interface Specialist	5	consulted regarding context and relevance potential measures, and associated data sources
SCA Biotech	4	aided in discussion and development of select measure protocols

Time Wilderness Fellow spent to identify, prioritize, and select all the measures (in whole hours)	Time Wilderness Fellow spent to learn how to enter data into the WCM database application (in whole hours)	Time Wilderness Fellow spent to enter all data into the WCM database application (in whole hours)	Time Wilderness Fellow spent on other tasks directly related to WCM (e.g., reading CCP, giving presentations, talking with staff) (in whole hours)	Time Wilderness Fellow spent doing <u>other</u> Refuge tasks not directly related to WCM (in whole hours)
100	8	8	100	144

APPENDIX C – Data sources and protocols for all measures used

Keeping Track of Wilderness Character Monitoring Measures

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Untrammeled Quality		
1.1 Number of actions to manipulate vegetation; fish, wildlife, insects, and disease; soil and water	M	<p>Data Source(s): Project Leader; RAPP Report raw data; MRAs</p> <p>Data Collection Protocol: The refuge Project Leader will be aware of all actions taken to manipulate natural aspects of the wilderness, including: vegetation, fish, wildlife, insects, disease, soil, and water (supporting data for which can be derived from annual RAPP Report figures, as well as existing MRAs). The total number of such actions taken during a given monitoring period will serve as the data value. Appendix D provides an in-depth guide to the concept of “trammeling”, and what constitutes a trammeling action. Furthermore, Table 1 indicates general rules for counting and reporting the number of actions for this measure.</p>
1.2 Number of naturally ignited wildfires suppressed	H	<p>Data Source(s): Fire Program; S:\Fire\Wildfire Records--Swanquarter NWR</p> <p>Data Collection Protocol: The refuge Fire Program will be aware of all naturally ignited wildfires within wilderness that received a suppression response. Fire Program personnel will be consulted for this information, which will also be incorporated into the above referenced shared drive file, and the total number of wildfires suppressed within wilderness during a given monitoring period will serve as the data value for this measure.</p>
1.3 Acres of wilderness burned by prescribed fire	H	<p>Data Source(s): Fire Program; S:\Fire\Rx Fire Usage--Swanquarter NWR</p> <p>Data Collection Protocol: The refuge Fire Program will be aware of all prescribed burns conducted within wilderness, and their associated acreage figures. Fire Program personnel will be consulted for this information, which will also be incorporated into the above referenced shared drive file, and the total number of acres burned by prescribed fire within wilderness during a given monitoring period will serve as the data value for this measure.</p>
1.4 Number of unauthorized actions that manipulate vegetation; fish, wildlife, insects, and disease; soil and	M	<p>Data Source(s): LE Officer; Project Leader; LE Database/Incident Reports</p> <p>Data Collection Protocol: The refuge LE Officer and Project Leader will be aware of all known, unauthorized actions taken to manipulate natural aspects of the wilderness, including: vegetation, fish, wildlife, insects, disease, soil, water, and fire. Formal documentation of such incidents will be housed within LE</p>

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
water; and fire		<p>database files. These sources will be consulted, and the total number of such actions taken during a given monitoring period will serve as the data value. Operational definitions of “action” and “unauthorized” are included below for reference. Examples of unauthorized trammeling would include actions by agencies, citizen groups, or individuals that manipulate the biophysical environment, and in many cases would be considered illegal (ex: poaching, arson, etc.). See Appendix D for an in-depth guide to the concept of “trammeling”, and what constitutes a trammeling action.</p> <p>Operational Definitions:</p> <ul style="list-style-type: none"> - <i>Action</i>— the implementation of an intentional decision to manipulate the biophysical environment. - <i>Unauthorized</i>— any action undertaken by any individual, group, or agency without specific approval by the federal land manager. (Any action that manipulates the biophysical environment of wilderness requires such approval.)
Natural Quality		
2.1 Population dynamics of select native species: Forster’s Tern	H	<p>Data Source(s): S:\Refuge Monitoring and Research\Swanquarter Tern Colonies</p> <p>Data Collection Protocol: Surveys to determine the number of tern colonies and nests within the wilderness will be conducted annually, and the resulting data will be housed within the above referenced shared drive file. Based on 5 year data sets, refuge staff will interpret the population dynamics of Forster’s Tern within the Swanquarter Wilderness, and score the population dynamics of the species according to the following system: 0 = Forster’s Tern population is stable, 1 = Forster’s Tern population is increasing, -1 = Forster’s Tern population is decreasing. The population dynamics score for Forster’s Tern during a given monitoring period will serve as the data value.</p>
2.2 Population dynamics of select native species: Common Tern	H	<p>Data Source(s): S:\Refuge Monitoring and Research\Swanquarter Tern Colonies</p> <p>Data Collection Protocol: Surveys to determine the number of tern colonies and nests within the wilderness will be conducted annually, and the resulting data will be housed within the above referenced shared drive file. Based on 5 year data sets, refuge staff will interpret the population dynamics of Common Tern within the Swanquarter Wilderness, and score the population dynamics of the species according to the following system: 0 =</p>

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
		Common Tern population is stable, 1 = Common Tern population is increasing, -1 = Common Tern population is decreasing. The population dynamics score for Common Tern during a given monitoring period will serve as the data value.
2.3 Ozone air pollution	M	Data Source(s): FWS NWRS Branch of Air Quality Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.
2.4 Total nitrogen wet deposition	M	Data Source(s): FWS NWRS Branch of Air Quality Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.
2.5 Total sulfur wet deposition	M	Data Source(s): FWS NWRS Branch of Air Quality Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.
2.6 Visibility	M	Data Source(s): FWS NWRS Branch of Air Quality Data Collection Protocol: This measure is part of a set of 4 metrics designed to monitor air quality in wilderness. All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent 5 yr. averages for each metric.
2.7 Acres of wilderness (loss of land area due to erosion)	H	Data Source(s): S:\Wilderness\Erosion Data Collection Protocol: Aerial imagery and GIS software will be used to compute the number of terrestrial acres comprising the Swanquarter Wilderness. The number of terrestrial acres of wilderness present during a given monitoring period will serve as the data value.
2.8 Cumulative change in marsh sediment height	H	Data Source(s): S:\Refuge Monitoring and Research\Sea level rise; Inventory & Monitoring RSET Representative Data Collection Protocol: There are currently three rod surface elevation table (RSET) stations located within the Swanquarter Wilderness, and each station collects 36 sediment elevation point measurements. To determine the current marsh sediment height (corrected for sea level rise) for the wilderness, the average of all 36 measurements across all three RSET stations will be taken. The data value sought for this wilderness character measure is the change in marsh sediment height (in millimeters) as compared to the initial sediment elevation measurement obtained during the

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
		baseline year of the RSET station (baseline, in this context, refers to the first initial measurements obtained by the RSET station, and does not represent the baseline of the wilderness character measure). To obtain this data value, the initial, averaged, sediment height measurement will be subtracted from the current, averaged, sediment height measurement during a given monitoring period, yielding the cumulative change in sediment height from the initial elevation.
Undeveloped Quality		
3.1 Number of authorized physical structures, installations, and developments	M	<p>Data Source(s): Project Leader; Real Property Database; SAMMS Database</p> <p>Data Collection Protocol: The Project Leader will be aware of all authorized physical structures, installations, and developments within wilderness, with supporting data available through the Real Property and SAMMS databases. These sources will be consulted, and the total number of authorized physical structures, installations, and developments within wilderness, during a given monitoring period, will serve as the data value. Temporary installations will be counted the same as permanent structures, and each data value reported will include all temporary installations that occurred within wilderness over the course of the corresponding year (regardless of how long a particular installation may have remained in the wilderness).</p>
3.2 Acres of Inholdings within wilderness	M	<p>Data Source(s): Project Leader; CCP; S:\Wilderness</p> <p>Data Collection Protocol: The refuge Project Leader will be aware of all existing inholdings within the wilderness area, and will be consulted for acreage data. Reference documentation would be found within the refuge CCP and wilderness file. The sum of all inholding acres present during a given monitoring period will serve as the data value.</p>
3.3 Number of projects/events for which non-emergency use of motorized transport, motorized equipment, or mechanical transport was authorized	H	<p>Data Source(s): Project Leader; Fire Program; LE Officer; MRAs</p> <p>Data Collection Protocol: The Project Leader will be aware of all projects/events for which use of motorized transport, motorized equipment, or mechanical transport was authorized, as the Project Leader will be responsible for the approval of such requests. Additionally, the refuge Fire Program and LE Officer, representing parties likely to request such authorizations and utilize motorized transport, motorized equipment, or mechanical transport as part of their job duties, may also serve as valuable sources of information. Existing MRAs should also be consulted as sources of official documentation for such projects/authorizations. The Project Leader and other sources as necessary (including, but not limited to, the refuge Fire Program and LE Officer, and any existing</p>

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
		<p>MRAs) will be consulted, and the total number of projects/events for which use of motorized transport, motorized equipment, or mechanical transport within wilderness was authorized during a given monitoring period will serve as the data value. General definitions of motorized and mechanical, as pertaining to this measure of wilderness character, have been sourced from the Forest Service's <i>Technical Guide for Monitoring Selected Conditions Related to Wilderness Character</i>, and are provided below for conceptual reference.</p> <p>“Motorized Equipment. Machines that use a motor, engine, or other nonliving power sources. This includes, but is not limited to, such machines as chain saws, aircraft, snow mobiles, generators, motorboats, and motor vehicles. It does not include small battery or gas powered hand carried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment.”</p> <p>“Mechanical Transport. Any contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and that is powered by a living or nonliving power source. This includes, but is not limited to, sailboats, hand gliders, parachutes, bicycles, game carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snow shoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts.”</p>
Solitude or Primitive and Unconfined Quality		
4.1 Area of wilderness occupied by marine debris	M	<p>Data Source(s): S:\Wilderness\Marine Debris Surveys</p> <p>Data Collection Protocol: Marine debris surveying will be conducted once per year across the Swanquarter Wilderness. The surveyor(s) will travel the perimeter of the wilderness islands and shorelines by boat, and the following procedure will be utilized to quantify the presence of marine debris within the Swanquarter Wilderness:</p> <p>While surveying the shored perimeter of the wilderness, each observed occurrence of marine debris will be expressed via the product of two parameters: area of shoreline occupied by debris, and percent cover of debris within that particular area. To obtain the first data component, the surveyor(s) will estimate the length of shoreline (in feet) occupied by a distinct occurrence of marine</p>

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
		debris, and multiply that number by the estimated width/depth of shoreline (in feet) occupied by the same observed occurrence of debris, thereby yielding the area (ft ²) occupied by a given occurrence of marine debris. To obtain the second data component for a given observation of marine debris, the surveyor(s) will estimate the percent cover of debris within the estimated area of shoreline (reference diagrams of percent cover will be used to aid in the accuracy and precision of these estimations—see Appendix E). The estimated values of area and percent cover for a given observed occurrence of marine debris will then be multiplied, and the resulting value constitutes a representation of the quantity of marine debris in the form of area occupied as corrected for percent cover. The corrected area values for all observed occurrences of marine debris throughout the wilderness will be summed, and the total area of wilderness occupied by marine debris (as corrected for percent cover), during a given monitoring period, will serve as the data value. An illustration of this complete process based on hypothetical data has been included for reference (see Figure 2 and Table 2).
4.2 Intrusions on the natural soundscape	M	<p>Data Source(s): S:\Wilderness\Soundscape Surveys</p> <p>Data Collection Protocol: Surveys of anthropogenic noise <u>originating from outside the wilderness</u> will be conducted twice per year in conjunction with RSET data collection (soundscape intrusion sampling will begin after collection of all required RSET data). From the first RSET station (SWAN000A), the surveyor(s) will listen for anthropogenic sounds originating from outside the wilderness (ex: motorboats, aircraft, etc.) for a sampling period of 15 minutes, using a stopwatch to measure the collective time of all such sounds experienced during the sampling period. The sum total time (in minutes) anthropogenic noise was experienced between the two annual surveys during a given monitoring period will serve as the data value. The length of the survey periods may be increased as needed should they regularly become maxed out with anthropogenic noise.</p>
4.3 Agency provided recreation facilities	M	<p>Data Source(s): Project Leader; Real Property Database; SAMMS Database</p> <p>Data Collection Protocol: The refuge Project Leader will be aware of all authorized recreational structures and facilities. Additionally, formal documentation of all such structures and facilities would be found within the Real Property database and SAMMS database. These sources will be consulted, and counts of all facilities representing authorized recreational development within wilderness will be collected and totaled. The total count of all such facilities present within wilderness, during a given monitoring period, will serve as the data value. General examples of</p>

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
		<p>recreational facilities are provided below for reference. These examples are purely for conceptual reference, and are not intended to be all inclusive, nor representative of the specific recreational facilities likely to occur within this particular wilderness area.</p> <p>Recreational facilities counted under this measure include, but are not limited to:</p> <ul style="list-style-type: none"> - Toilets - Constructed tent pads or sleeping structures - Picnic tables - Developed/permanent fire rings/grates - Shelters - Watercraft docking facilities - Developed water sources
4.4 Management restrictions on visitor behavior	M	<p>Data Source(s): Project Leader</p> <p>Data Collection Protocol: Table 3, sourced from the Forest Service's <i>Technical Guide for Monitoring Selected Conditions Related to Wilderness Character</i>, contains a list of management restrictions placed on visitor behavior, as well as scores assigned based on the degree of restriction, and the significance of their impact on opportunities for primitive and unconfined recreation. When scoring the restrictions of a given wilderness, a geographical weight is also applied: x1 = restriction applies only to a portion of the wilderness; x2 = restriction applies throughout entire wilderness. Based on the stipulations of management policy within a given monitoring period, the wilderness will be scored, and the total score will serve as the data value. Table 4 illustrates this scoring process for the Swanquarter Wilderness based on management restrictions in place at the time of this report.</p>

APPENDIX D – Trammeling guide

WHAT IS A TRAMMELING ACTION?

Peter Landres, Aldo Leopold Wilderness Research Institute

The purpose of this short document is to provide guidelines and examples to clarify what is and is not a trammeling action. This document does not discuss how to weight such actions, how to find or record the data for these actions, or any other aspect of using this information in wilderness character monitoring. These guidelines and examples are intended to capture about 90% of the cases and provide sufficient guidance for local staff to figure out the novel and rarer cases as they occur.

The following definitions are used in this document:

- Trammeling action: an action that intentionally manipulates “the earth and its community of life” inside a designated wilderness or inside an area that by agency policy is managed as wilderness.
- Intentional: done on purpose; deliberate; willful
- Manipulation: an action that alters, hinders, restricts, controls, or manipulates “the earth and its community of life” including the type, amount, or distribution of plants, animals, or physical resources inside a designated wilderness or inside an area that by agency policy is managed as wilderness.
- Intentional manipulation: an action that purposefully alters, hinders, restricts, controls, or manipulates “the earth and its community of life.”

Based on these definitions, trammeling occurs when a manager makes a decision and takes action that intentionally manipulates the Natural Quality. Once action is taken the effect on the Natural Quality cannot typically be halted or stopped or reversed, and therefore the effect typically persists from the moment of the action onwards over time. Because of this persistent or permanent effect on “the earth and its community of life,” managers need to think long and hard about these types of decisions.

Trammeling actions are often considered only in terms of how they degrade the Untrammelled Quality, but the agency takes all sorts of such actions for many different reasons that support or sustain the other qualities of wilderness character. For example, actions taken to protect and sustain the Natural Quality include controlling or eradicating non-native species, restoring degraded habitat, or protecting species from harm such as installing gates across caves to prevent people from entering. Resource management actions in wilderness almost always involve tradeoffs, and while there may be valid and good reasons for taking trammeling actions, these actions nonetheless degrade the Untrammelled Quality. The framework of wilderness character simply allows agency staff to be transparent about these tradeoffs, for example the tradeoffs that might be involved in actions taken to improve the Natural Quality that degrade the Untrammelled Quality. The goal of using the framework of wilderness character is to help agency staff make the decision that is deemed best overall for preserving wilderness character.

TYPES OF TRAMMELING ACTIONS

There are two broad classes of trammeling actions, those that are authorized by the federal land manager and those that are not. Under each of these broad classes there are several subclasses that reflect whether the action is taken on a biological resource, a physical resource, and whether the effect of the action is on a biological or physical resource. Almost always the concern is for actions that occur

inside a designated wilderness, but one subclass provides examples of actions taken outside a designated wilderness that would be included as a trammeling action because the intention is to affect biological or physical resources inside the wilderness.

Agency authorized trammeling actions – actions authorized by the federal wilderness land manager as well as actions by other agencies, organizations, or individuals that have been approved or permitted by the federal land manager

1. Actions taken inside the wilderness on vegetation or fish and wildlife to intentionally and directly affect this vegetation or fish and wildlife. Examples include:
 - a. Removing or killing native vegetation or fish and wildlife
 - b. Adding or restoring native vegetation or fish and wildlife
 - c. Adding non-native vegetation for erosion control
 - d. Adding non-native fish and wildlife
 - e. Spraying chemicals to control non-native vegetation or fish and wildlife
 - f. Releasing biocontrol agents to control non-native vegetation or fish and wildlife
 - g. Collecting vegetation for scientific study
 - h. Collecting or capturing and releasing fish and wildlife for scientific study
 - i. Collecting vegetation or fish and wildlife for commercial purposes
 - j. Enclosing or excluding fish and wildlife from an area to protect vegetation or to study the effects of enclosing or excluding fish and wildlife on protecting vegetation or animals
 - k. Adding piscicides to water to eliminate non-native fish
2. Actions taken inside the wilderness on a physical resource to intentionally and directly affect this physical resource. Examples include:
 - a. Suppressing naturally-ignited fire
 - b. Lighting fire (under management prescription) to reduce fuels or for other purposes
 - c. Constructing or maintaining a dam or diversion structure to alter the quantity or seasonal flow of water
 - d. Constructing a road to allow access to mineral, oil, or gas leases; communication sites; or inholdings
3. Actions taken inside the wilderness on a physical resource that intentionally affects the physical resource to directly or indirectly affect vegetation or fish and wildlife. Examples include:
 - a. Installing a gate across a cave that will protect bats but exclude other animals from using the cave
 - b. Constructing or maintaining a range allotment fence
 - c. Constructing a dam to exclude non-native species from moving up or down a stream
 - d. Installing guzzlers to provide water for wildlife
 - e. Lighting fire (under management prescription) or any other vegetation manipulation to improve wildlife habitat
 - f. Adding acid-buffering limestone to water to neutralize the effects of acid deposition on aquatic flora and fauna
4. Actions taken outside the wilderness on a physical or biological resource to intentionally and directly affect that resource inside a wilderness. Examples include:
 - a. Cloud seeding that occurs above the wilderness, and is therefore outside it, to intentionally increase precipitation inside the wilderness

- b. Damming a river outside a wilderness to intentionally create a lake or water storage area inside the wilderness
- c. Killing fish and wildlife outside the wilderness to intentionally affect the population or distribution of this species inside the wilderness
- d. Planting or stocking fish and wildlife outside the wilderness to intentionally or foreseeably affect the population or distribution of this species inside the wilderness because of known habitat inside the wilderness

Unauthorized trammeling actions – citable and other actions taken by other agencies, organizations, or individuals that have not been authorized, approved, or permitted by the federal wilderness land manager

1. Actions taken inside the wilderness on vegetation or fish and wildlife to intentionally and directly affect this vegetation or fish and wildlife. Examples include:
 - a. Adding vegetation or fish and wildlife by a federal agency (other than the federal land managing agency), a state agency, or the public
 - b. Removing vegetation or fish and wildlife by a federal or state agency or the public
 - c. Inclosing or excluding fish and wildlife to study the effects of inclosing or excluding on vegetation or fish and wildlife
2. Actions taken inside the wilderness on a physical resource to intentionally and directly affect this resource. Examples include:
 - a. Modifying water flow to store water or alter the timing of water flow
 - b. Setting arson fire
3. Actions taken inside the wilderness on a physical resource that intentionally affects the physical resource to intentionally (either directly or indirectly) affect vegetation or fish and wildlife. Examples include:
 - a. Modifying water resources to provide water for wildlife
4. Actions taken outside the wilderness on vegetation or fish and wildlife to intentionally and directly affect the occurrence or distribution of these or other species inside a wilderness. Examples include:
 - a. Releasing species outside a wilderness with the intention to affect a population whose range expands into the wilderness
 - b. Killing wildlife outside of the wilderness with the intention to affect populations whose ranges expand into the wilderness

FLOWCHART

In addition to the examples above, the flowchart below is intended to help agency staff determine when an action should be considered a trammeling action. In this flowchart, all of the examples described above would typically fall under the far left branch as trammeling actions, although they may occur under the middle branch of maybe being a trammeling action depending on the circumstances. The flowchart begins with the question “Is there an opportunity for restraint?” because at root the idea behind “untrammeling” is the legislative and policy mandate that managers use restraint in wilderness stewardship. Simply, if there is no opportunity for managerial restraint, or for managers to try and restrain unauthorized action taken by others, then there is no impact to the Untrammeling Quality even though there may be large impacts to the Natural Quality. This question is placed first in the flowchart to help avoid confusing those actions and their effects for which managers typically lack the opportunity for restraint and where there is no intention to manipulate wilderness, such as global climate change, air

pollutants, and many others, from actions that intentionally affect “the earth and its community of life” and that managers do have an opportunity to influence.

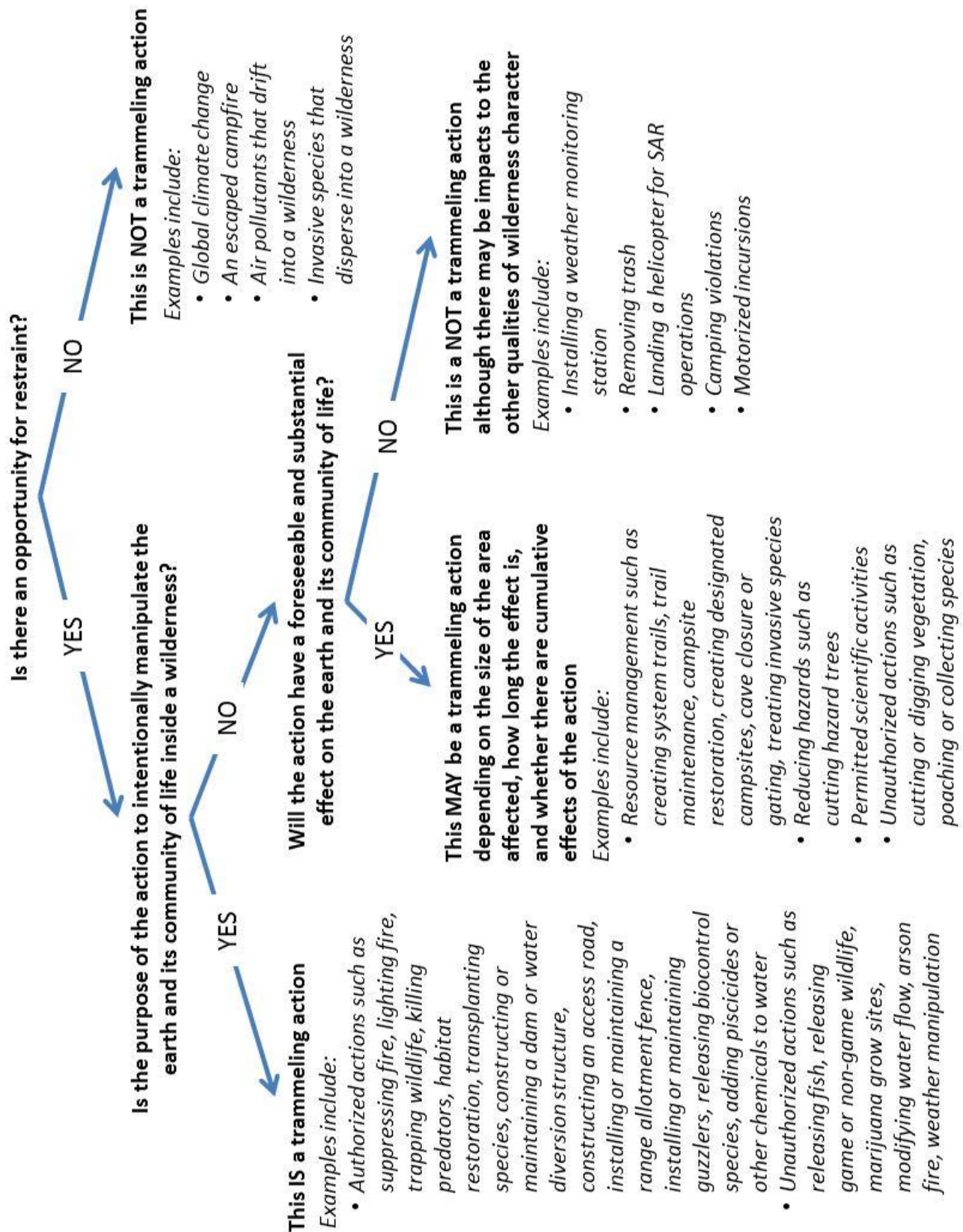
In some situations managers may assume that they do not have the opportunity for restraint, for example taking action to restore habitat for a listed endangered species, or spraying herbicides to eradicate an invasive non-native plant that is degrading wildlife habitat, or transplanting an extirpated species back into the wilderness, or suppressing a naturally-ignited fire to save timber or homes adjacent to the wilderness. However, even in these situations managers are choosing to take action as well as the type and intensity of action. In addition, there are many situations where managers must choose to take an action that supports one law (such as the Endangered Species Act) that degrades another (in this case the Wilderness Act), or they must make difficult tradeoffs because of agency policy. In all of these situations there is an opportunity for restraint, and these guidelines and flowchart should help managers be consistent and transparent in making these decisions.

If there is an opportunity for restraint, the manager must then consider the intent of the action. Intent is notoriously difficult to discern, but in many cases deciding whether an action is an intentional trammel is straightforward, while in other cases it is more complex and nuanced. These nuanced cases typically involve some type of action where the intent is not to manipulate the “earth and its community of life” but to have some other outcome that is limited in its scope and effect. On the flowchart these situations are under the question “Will the action have a foreseeable and substantial effect on the earth and its community of life?” These nuanced cases may be confusing because even though the primary intent is not to manipulate species or physical resources, action is nonetheless intentionally being taken and there may be a foreseeable and substantial effect on “the earth and its community of life.”

In the table below, several hypothetical situations illustrate how an action may or may not be a trammeling depending on the scope and scale of the action and its effects. Each bullet in the table presents a situation where the action being taken likely would, or would not, be considered a trammeling. For every real situation, agency staff need to think through whether the proposed action will have a foreseeable and substantial effect on “the earth and its community of life” and if their answer is “yes” then it’s a trammeling action, and if the answer is “no” then it’s not a trammeling action. Also, in this table an action may not be a trammeling but it still may affect other qualities of wilderness character. For example, installing rebar monummentation would likely not be a trammeling, but such installations would likely degrade the Undeveloped Quality.

Action	Likely Not a Trammeling	Likely a Trammeling
Building system trail	<ul style="list-style-type: none"> • Routing a trail needs around a rock slide that obliterated the former trail • Building a bridge across a stream to prevent stream bank erosion • Installing a small section of corduroy across a wet area to prevent trenching • Installing in water bars • Removing rock in a trail • Building rock-cribbing to support a trail 	<ul style="list-style-type: none"> • Routing a trail through an area of endangered alpine butterfly habitat • Building a large amount of new trail to go around a section of a river or a cliff • Building a trail that requires extensive earth movement or tree cutting
Obliterating non-system trail	<ul style="list-style-type: none"> • Piling vegetation or rocks at the beginning and end of trail sections that cut a switchback 	<ul style="list-style-type: none"> • Obliterating a large section of non-system trail that requires extensive earth movement

Action	Likely Not a Trammeling	Likely a Trammeling
	<ul style="list-style-type: none"> • Piling vegetation or rocks to block social trails around campsites 	
Restoring campsites	<ul style="list-style-type: none"> • Restoring a single, isolated campsite • Restoring a number of campsites (e.g., that are clustered around a lake) that doesn't require degrading the soil or vegetation in the surrounding area 	<ul style="list-style-type: none"> • Restoring a number of campsites that does require moving a significant amount of soil or number of plants in the surrounding area
Closing caves	<ul style="list-style-type: none"> • Installing a bat gate across one or a few caves of many in the area 	<ul style="list-style-type: none"> • Installing bat gates across all the caves in an area
Removing hazard trees	<ul style="list-style-type: none"> • Removing one or a few hazard trees that threaten designated campsites or that are along a trail 	<ul style="list-style-type: none"> • Removing all of the hazard trees over a large area
Treating non-native invasive plants	<ul style="list-style-type: none"> • Hand pulling a small area of non-native invasive plants 	<ul style="list-style-type: none"> • Spraying any herbicide
Permitting scientific activities	<ul style="list-style-type: none"> • Installing research plot monumentation, such as rebar stakes or nails • Installing most scientific instrumentation • Collecting a limited number of voucher specimens with no impact species distribution or abundance 	<ul style="list-style-type: none"> • Installing enclosures or exclosures that affect the movement of fish and wildlife • Installing instrumentation that disrupts the movement or behavior of plants, or fish and wildlife • Collecting voucher specimens that does affect the species distribution or abundance



PERCENT COVER

